PREFABRICATED BUILDING WITH SELF-ALIGNING SECTIONS AND METHOD OF MANUFACTURE AND ASSEMBLY OF SAME

FIELD OF THE INVENTION

[0001] This invention is in the field of buildings, and in particular in the field of buildings that are partially prefabricated.

BACKGROUND

[0002] The construction of structures is labor-intensive and expensive. Residential homes, for example, are typically constructed entirely on their foundations. Wooden and steel frames, interior walls, exterior walls, roofs and other elements are typically all assembled from component lumber, drywall and other items, at the construction site. A wide variety of inputs, including specific materials, and specific construction skills, must be combined at the site. Particularly in the aftermath of natural disasters, such as hurricanes, tornadoes, or fires, both materials and supplies, and skilled labor, are often unavailable in the region around the construction site. The process at the site is necessarily time-consuming. As a result of the length of time to complete construction, financing costs on the property at the construction site are increased. In some construction techniques, certain components of a building are assembled at a remote location and then transported to the construction site. Partial assembly at a factory reduces the typical duration of work at the construction site, thereby reducing financing costs. The assembly can be carried out using factory labor, rather than skilled labor, thereby reducing labor costs. However, the transportation of large components, such as assembled walls, by road, results in oversized loads, which increase transportation costs substantially. In view of the transportation costs, it has generally been acknowledged that assembly of large components more than about 300 miles from the construction site is not economical. This limited range also makes it more difficult to employ factory assembly as a partial solution to local shortages of materials and skilled labor. The limited range of transportation of large components renders impractical taking advantage of considerable variations in wages between relatively distant regions. Transportation of large components by road also exposes structures to stresses not conventionally encountered by buildings.

[0003] It is an object of the invention to overcome the foregoing disadvantages of the prior art.

[0004] It is an advantage of the invention that the foregoing disadvantages of buildings and construction techniques of the prior art are overcome.

[0005] Additional objects and advantages of the invention will become evident from the detailed description which follows.

SUMMARY OF THE INVENTION

[0006] A method of the invention includes a method of manufacture and assembly of a structure. The method includes the steps of providing sections, having structural supports and optionally at least external or interior finish features, self-aligning or rotatably attached to one another, to define a structure section, and positioning the structure section in an assembled position. At a first location, the sections may be temporarily fixed. The structure may be checked for fit and quality control, and any corrections made at that point. The building section may be removed from its assembled position, placed in a folded position, transported to a second location, mounted in an assembled position, with the sections fixed. Interior and exterior features may then be finished to complete the structure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Fig. 1 is a view of a wall section in accordance with the invention with interior finish removed.

[0008] Fig. 2 is a view of a wall section in accordance with the invention with the interior finish in place.

[0009] Fig. 3 is an isometric view of a building segment in accordance with the invention, in its folded or shipping orientation.

[0010] Fig. 3A is a detail of Fig. 3.

[0011] Fig. 4 is a side view of the building segment of Fig. 3.

[0012] Figs. 4A and 4B are details of Fig. 4.

[0013] Fig. 5 is an isometric view of the building segment of Fig. 3 shown partially unfolded.

[0014] Fig. 5A is a detail of Fig. 5.

[0015] Fig. 6 is an isometric view of the building segment of Fig. 3 in its extended orientation.

[0016] Fig. 6A is a detail of Fig. 6.

[0017] Fig. 7 is an isometric view of the building segment of Fig. 3 at a later stage of assembly.

[0018] Fig. 7A is a detail of Fig. 7.

[0019] Fig. 8 is an isometric view of the building segment of Fig. 3 at a later stage of assembly.

[0020] Fig. 8A is a detail of Fig. 8.

[0021] Fig. 9 is an isometric view of the building segment of Fig. 3 at a later stage of assembly.

[0022] Fig. 9A is a detail of Fig. 9.

[0023] Fig. 10 is an isometric view of a folded building segment in an exploded view with a container.

[0024] Fig. 11 is a view of the building segment of Fig. 10 in an unfolded view.

[0025] Fig. 12 is a simplified isometric view of a partially completed building in accordance with the invention.

[0026] Fig. 13 is a simplified isometric view showing another stage of completion of the building of Fig. 12.

[0027] Fig. 14 is an isometric view of an alternative building segment of the invention in a folded or shipping orientation.

[0028] Fig. 15 is an isometric view of the building segment of Fig. 14 in an assembled orientation.

[0029] Fig. 15A is an isometric view of an embodiment of a building section of Fig. 15.

[0030] Fig. 16 is an isometric view of a bracket in accordance with the invention.

[0031] Fig. 17 is another view of the bracket of Fig. 16.

[0032] Fig. 18 is another view of the bracket of Fig. 16.

[0033] Fig. 19 is another view of the bracket of Fig. 16.

[0034] Fig. 20 is a view of an alternative bracket in accordance with the invention.

[0035] Fig. 21 is a view of another alternative bracket in accordance with the invention.

[0036] Fig. 22 is an exploded view of a window in accordance with the invention.

[0037] Fig. 22A is a detail of Fig. 22.

[0038] Fig. 23 is a somewhat schematic view of an alternative structure segment in accordance with the invention in an assembled orientation.

[0039] Fig. 24 is a view of the structure segment of Fig. 23 at a step of assembly.

[0040] Fig. 25 is a view of the structure segment of Fig. 23 at a step of assembly.

[0041] Fig. 26 is a view of the structure segment of Fig. 23 at a step of assembly.

[0042] Fig. 27 is a view of the structure segment of Fig. 23 at a step of assembly.

[0043] Fig. 28 is a view of the structure segment of Fig. 23 at a step of assembly.

[0044] Fig. 29 is a view of the structure segment of Fig. 23 at a step of assembly.

[0045] Fig. 30 is a view of the structure segment of Fig. 23 at a step of assembly.

[0046] Fig. 31 is a view of the structure segment of Fig. 23 at a step of assembly.

[0047] Fig. 32 is a view of the structure segment of Fig. 23 in a folded or shipping orientation.

[0048] Fig. 33 is a view of structure segment according to the invention having a removable internal wall.

[0049] Fig. 34 is another view of the structure segment of Fig. 33.

[0050] Fig. 35 is a view of a structure segment showing a lift in accordance with the invention.

[0051] Fig. 36 is a view of the segment of Fig. 35 showing the lift in a closed position.

[0052] Fig. 37 is an exploded view of a window and trim in accordance with the invention.

[0053] Fig. 38 is a view of the window and trim of Fig. 37.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0054] A method of the invention includes, in one aspect, a method of construction of a structure. The method includes the steps of assembling a structure having sections, including at least structural supports, constructed for self-alignment. The sections may, in some embodiments, be rotatably attached to one another prior to assembly. The sections may have, in addition to structural parts, interior or exterior finish material, or both.

[0055] The structure may take a wide variety of forms. The structure includes walls and a roof of a building suitable for use as a residence, storage, industrial, commercial, office and similar uses. The structure may be an open roof structure, such as a stadium. The completed structure refers to a structure which is suitable for use. In a typical structure, a structure is completed when an exterior surface is substantially complete, and when interior surfaces are completed.

[0056] The sections of the structure provides structural support, bearing all or most of the load of the structure. The structural support may include beams. Beams may include elongated rigid bars of metal, wood or composite materials, but may be made of any material or combination of materials and may be of any shape. The structural support may be provided by concrete blocks, with or without metal or composite reinforcement, for example.

[0057] In some embodiments, rotatable connections are provided among at least some of the sections. The joints permit at least some rotation between adjacent sections. The joints may be of any construction, although preferred constructions are described.

[0058] Interior finish features include interior walls, of various materials, including drywall and wooden paneling, attached to the beams to define rooms. Interior wall surfaces may have finishes, such as paint or wallpaper. Interior wall surfaces may include openings for utilities, such as for electrical boxes for outlets and switches, openings for telephone, fiber optic and other types of communications wire and cable, and for water pipes for attachment of appliances.

[0059] Exterior finish surfaces will typically include a water-impermeable outer skin, of such materials as composites, aluminum, or treated or painted wood.

[0060] An exemplary method of the invention will now be explained, with reference to the figures.

[0061] Referring to Fig. 1, there is shown a sample wall section 100 of a structure in accordance with the invention. Wall section 100, which is exemplary, is for use in a structure, such as a residential building, such as a single family home, apartment building, motel or hotel. Wall section 100 includes a plurality of vertical studs 104, which serve as structural supports. Wall section 100 is preferably assembled at a first location, which first location is distinct from the location of the placement of a structure of which wall section 100 is to be a part. For example wall section 100 may be intended for use in a structure to be placed on a foundation at a second location.

[0062] The first location may be a factory or other location for specialized assembly of structures and possibly other items. A variety of advantages may be obtained by use of factory assembly over assembly at a construction site. The factory may be located closer to sources of supply of inputs than the construction site. A factory offers better control over environmental conditions. Greater efficiencies in use of materials and in methods of fabrication and assembly of components may be obtained. The first location and second location may both be in the same country or economic area (e.g., the United States or the European Union). Shipment by ground transportation between the first and second location may be available. The first and second locations may be in different countries, but shipment by ground transportation, including truck and train, may be feasible. Truck transportation may include transport of trucks by ship for relatively short distances. The first and second locations may be on different continents, and wall section 100 may be transported by ship. Wall section 100 may be placed in a shipping container and shipped by one or more of water, rail and road.

[0063] Studs 104 are elongated rigid bars, which may be of metal, wood or composite materials. Studs 104 may be of the same material and dimensions as studs of conventional construction, or may be of suitable differing dimensions and materials. It will be appreciated that the rectangular cross-section may also be varied within the scope of the invention. Studs 104 may be of conventional size and materials. In this example, studs 104 are equally spaced from one another. Spacing may be the same as in conventional construction, or may be varied as appropriate depending on materials and load. Spacing is maintained in this embodiment by attachment of studs to exterior finish material, but may be maintained by intermediate studs, bars, rods or other rigid spacers, by sill plates, or any other appropriate manner.

[0064] Wall section 100 also has external finish features identified generally at 130. External finish features 130 include, in this example, exterior siding 116 and exterior sheathing 120. It will be appreciated that exterior finish features may vary. Exterior siding 116 and exterior sheathing 120 may be permanently attached to studs 104. External finish features may include any suitable weather resistant material, including aluminum panels, composite, wooden panels (clapboard), and other materials. Spaces between studs 104 may be filled with insulation 136, which may be fiberglass batting, foamed plastic panels, or any other suitable form of insulation.

[0065] Wall section 100 also preferably includes utility components. Utility components may include provision for various cables and pipes, such as such as electrical cables 141, hot water supply pipes 142, and cold water supply pipes 143. Other cables and pipes, such as fiber optic cables, may be provided. Optionally, cables and pipes may be incorporated in raceways. Electrical cables may include fixed sections and flexible end sections for adjustment and connection to electrical cables in adjacent wall panels. Similarly, water pipes may include rigid sections and flexible sections for attachment to pipes in adjacent sections. Electrical boxes 145 may be provided at suitable locations, such as on sides of one or more studs 104, and connected to electrical cables, as discussed above. The boxes may serve as suitable placement of switches and outlets. At edges of wall section 100, connectors may be provided at terminations of cables 141, 142. Pipes and wiring may be configured with flexible connectors, to connect to adjacent wall sections, and for final attachment to fixtures. Alternatively, pipes and wiring may be made of flexible materials. By use of flexible materials, pipes and wires may be connected through or installed in

[0066] Window 124 is shown in wall section 100. The exemplary construction is generally conventional, with jack studs, a reinforced header, and a bottom plate. It will be appreciated that wall sections may be provided with windows of differing configurations, with differing numbers of windows, and with doors in addition to or in place of windows.

[0067] Referring to Fig. 2, the wall section of Fig. 1 is shown with an interior finish layer 122. Interior finish layer 122 may be drywall, paneling, or other suitable material. Finish layer 122 has openings to accommodate pipes, electrical connections, and for the window. It will be appreciated that drywall 122 is smaller than the lateral dimensions of wall section 100. The

sizing of drywall 122 will leave space between adjacent wall sections 100, thereby permitting workers to appropriately join connectors of adjacent wall sections 100. Drywall 122 may be of conventional thickness and construction fixed to studs 104 in a conventional manner, such as by screws or nails. Drywall 122 is preferably not attached by removable fasteners. Drywall 122 may have a coating, such as a primer coat of conventional paint. Drywall 122 may be made of a single sheet of drywall, or may be made of several sheets positioned adjacent one another.

[0068] Depending on the needs of the particular application, wall section 100 may be the entire height of a story in a structure, or may be a fraction of the height. Multiple wall sections 100 may be joined by hinged joints to permit folding for transportation.

[0069] A floor/ceiling section will have generally the same construction as wall section 100. Floor ceiling section may have a plurality of parallel, rigid elongated beams providing structural strength. Beams may be made of the same materials as studs 104. Beams will typically be required to support greater loads than studs, and thus will be larger or heavier. Floor/ceiling sections may have finish surface, namely a floor surface, on one side thereof. Floor surface may be of conventional flooring construction, or otherwise. For example, floor surface may include a sheet of plywood, metal or composite attached to beams by nails or screws. Floor surface may include a finish surface such as carpeting or finished wood boards attached to the sheet.

[0070] A floor/ceiling section may have on an opposite side from floor surface a second finish surface, namely ceiling surface. Ceiling surface may be generally similar to the finish surfaces of wall section 100. Alternatively, ceiling surface may be of any material suitable for a ceiling surface of a structure.

[0071] Floor/ceiling section may have, as with wall section 100, utility components interior thereto. Such utility components may include cables, pipes, ducts and the like, and/or raceways for insertion of electrical and communications cabling, pipes and ducts, openings for electrical fixtures, openings for plumbing fixtures, raceways suitable for electrical cabling, communications cables, pipes and ducts. Floor/ceiling sections may have utility components, such as provisions for integrated utility functions, such as radiant floor heating.

[0072] The assembly of various wall sections and floor/ceiling sections into a structure segment will now be explained with reference to the exemplary structure segment shown as Fig.

3. Structure segment 300 is shown, for purposes of ease of viewing, in a partially unfolded configuration. However, structure segment 300 will ordinarily be in this orientation only during the process of assembly and of packing for shipping.

[0073] Structure segment 300 will be seen to include three floor/ceiling sections, designated here as 310, 311 and 312. The number of floor/ceiling sections in a structure segment may be selected as desired. The lowest of the floor/ceiling sections, 310, is rotatably attached at each end thereof to a wall section, designated here 320, 321. Wall sections 320, 321 are in turn connected by a rotating, sliding attachment to intermediate floor/ceiling section 311. The rotating sliding attachment permits both the orientation of wall sections 320, 321 to floor/ceiling section 310, to change, and the point of attachment on floor/ceiling section 311 to change.

[0074] Floor ceiling section 311 has, in this example, two wall sections 324, 325 rotatably attached at each end and orientated upward, to form walls for a second story of a structure. Floor/ceiling section 311 also has rotatably attached thereto, intermediate its two ends, wall section 326. Wall section 326 is an interior wall section. Preferably, wall section 326 has been provided with interior finish surfaces, such as painted or unpainted drywall, or wooden paneling, prior to attachment. Wall sections 324, 325, 326 all have rotating/sliding attachments to a top floor/ceiling section 312.

[0075] Referring to Fig. 3A, there is shown in detail an exemplary rotating/sliding attachment. Wall section 320 has structural supports made of beams, e.g., beam 331. Beam 331 is pivotally attached to arm 334 at a first end of arm 334. A reinforcing sleeve 332 on the end of beam 331 may be provided. At a second end of arm 334 there is provided roller 335, which rolls or slides in a slot defined by a flange 315 on a beam of floor ceiling section 311.

[0076] The assembly of an exemplary building segment 300 will now be explained. Referring to Fig. 4, building segment 300 is shown in a fully folded position. Fig. 4A shows the orientation of arm 334 in the folded position. Fig. 4B shows the exterior finish features extending beyond the edge of side wall sections. The size of building segment 300 in a fully folded orientation is important. The folded dimensions must be no greater than the dimensions available during transport. For example, if, as illustrated below, building segment 300 is to be transported in a shipping container, the dimensions must be sufficiently small to permit insertion in the container. Typical shipping containers are 40 feet in length, and 7.5 feet in height and

width (approximately). If building segment 300 is to travel on a truck, the size is preferably sufficiently small that a standard roadgoing truck may be employed, without any need to designate the truck as carrying an oversize load. The maximum width of a load permitted without special oversize load permits varies, from about 8 feet, six inches, to about 10 feet or more.

[0077] Building segments may be of differing width depending on available transportation. For example, if transportation by road with oversize load designation is available, then, in the United States, the building segments may be significantly wider, such as up to 15 feet in width, and more than 15 feet in width, depending upon the route.

[0078] It will be seen, as in Fig. 4B, that the external finish 130 of the exterior wall sections extends beyond the studs and the interior finish. During shipping, the exterior finish extends laterally outward. Suitable supports and separators may be employed to prevent the load of upper floor/ceiling and wall sections from being supported on finish surfaces of lower sections.

[0079] Building segment 300 is moved to an assembled position, generally by lifting either on the upper portions only, or by lifting both the intermediate and top floor/ceiling sections. A variety of techniques may be employed, including cables tied to floor/ceiling sections and lifted by a crane, a scissors lift, as explained below, a fork lift engaging slots on the studs of the floor or ceiling sections, a system of driven cables, and other techniques. Fig. 3 is a partially opened view of building segment 300.

[0080] Fig. 5 is a further partially opened view of building segment 300, in which each floor/ceiling section is being lifted. Fig. 5A shows the orientation of arm 334 when building segment 300 is partially opened.

[0081] Fig. 6 shows building segment 300 in an extended position. Arms 334, as best seen in Fig. 6A, are preferably positioned so that, by continuing to lift, building segment 300 is in an extended position. In this position, each floor/ceiling section held in place is slightly above the upper part of the immediately below wall section. While building segment 300 is in an extended position, additional features, such as additional walls, bathroom and kitchen units, and other items, may readily be moved into place on the floor/ceiling section.

[0082] Building segment 300 may have additional panels added for a complete building. By way of example, referring to Fig. 7, side wall panel 360 may be added. Side wall panel 360 has been previously fabricated, similar to side walls 100, with structural members and internal and external finish features. Side wall panel 360 has opening 370 for doors and openings 372 for windows. Side wall panel 360 may have installed windows and doors. Side wall panel 360 is fixed to building segment 300 using suitable fasteners. If a test or preliminary assembly step is being carried out, side wall panel 360 is fixed to building 300 using reversible fasteners. The orientation of arm 334 may be seen in Fig. 7A. A similar wall section may be provided on the opposite side. A second floor side wall panel 380 may also be added and fixed to building segment 300, as shown in Fig. 8. The orientation of an arm 334a, similar to arm 334, may be seen in Fig. 8A. An internal wall partition wall engineered to fit into mating channels in the floor and ceiling may also be added here. The intermediate floor/ceiling section is then lowered to lock side walls into place, as shown in Fig. 9. Additional fasteners may be employed to lock all hinged connections into place.

[0083] Any additional interior and exterior finish items may be attached at the test location after locking of the hinged connections. Such finish items may include trim and moldings, external features, such as decks and balconies, and internal features, such as cabinets and counters. Electrical outlets, switches and devices may be connected to wiring, and cables may be connected among sections. Other cables, pipes and fixtures may be connected. All of the foregoing connections are preferably fully reversible, making use of reversible electrical connectors for electrical connections, and other reversible connectors.

[0084] The structure is then inspected for compliance with design specifications. Any errors in the manufacturing process that result in a failure of components to fit properly can be identified in such inspection and corrected. Replacement components can be obtained, or components altered for proper fit, or to correct other failures to comply with specifications. Inspections required to meet local building codes can be carried out. Code violations can be communicated by inspectors, and appropriate changes made to meet code can be made. If structures meet code, appropriate approvals or certificates can be issued at this time.

[0085] The above process is then reversed, and the structure disassembled and placed in its folded position for shipping.

[0086] An exemplary structure segment 1000 is shown in Fig. 10 in an exploded view as folded in an exemplary shipping container 1010. The structure segment 1000 is shown in Fig. 11 unfolded. A building with floor area greater than 1000 square feet may be contained in a single forty foot long, 7.5 feet by 7.5 feet shipping container.

[0087] Upon delivery in a shipping container, the structure is removed from the shipping container, such as by crane, and positioned on a foundation. The structure is raised, such as by a crane located on the site. The procedure described above for unfolding to an extended position, insertion of additional components and securing the structure is followed. Several building segments may be placed adjacent one another and connected together to form a single building. Final finish work, including closing seams around connections and joints between building structures, and application of final surface treatments, such as painting, may be completed.

[0088] An example is shown in Figs. 12 and 13. In this example, a foundation 1200 is shown at a location where a building is to be erected. Two building segments 1210 and 1220 in accordance with the invention have already been erected in Fig. 12. In Fig. 13, three segments 1210, 1220, 1230 are shown assembled and in place, with two additional segments 1240, 1250 on the foundation and partially unfolded, and three further segments 1260, 1270, 1280, to provide a garage, shown in orientation for shipping.

[0089] It will also be appreciated that the individual wall and floor/ceiling sections may be manufactured without provision for hinged connections. When the parts are assembled, they may be removably assembled together by reversible connections, such as various types of engineered locking devices, ties or screws. After testing, the connections are loosened, and the individual parts are packed for shipment. The parts may be packed in a container, similar to the discussion above. The parts may be loaded on suitable pallets or trailers, if desired. When the parts are delivered for final assembly, the parts are successively permanently attached to foundations and then to one another. The respective parts may be provided with features, such as mating protrusions and recesses, that will cause adjacent parts to be self-aligning. This variation still results in substantial cost savings upon assembly.

[0090] In Figs. 14 and 15, an alternative design of a structure segment 1400 is shown, in which wall sections are half the height of each story. This design obviates the need for sliding connections between wall and floor/ceiling sections. Rather, in this embodiment, all connections

are rotating, but not sliding. The design of Figs. 14 and 15 also provides an integrated sloping roof, particularly desirable in residential homes. This design may employ the sliding connections explained above in connection to provide a wide variety of possible structure configurations.

[0091] Lowest floor section 1405, in this example, has three wall sections 1410, 1415, 1420 rotatably attached thereto. Wall section 1410 has lower portion 1411 rotatably attached to floor section 1405, at one end of floor section 1405, and to upper portion 1412. Wall section 1415 has lower portion 1416 rotatably attached to floor section 1405, at a point intermediate between the ends of floor section 1405, and in this example at the center of floor section 1405. Lower portion 1416 is rotatably attached to upper wall portion 1418. Wall section 1420 has lower wall portion 1422 rotatably attached to an end of bottom floor section 1405, and rotatably attached to upper wall portion 1424. Each upper wall portion 1412, 1418, 1424 is rotatably attached at its upper end to central floor/ceiling section 1430. Floor/ceiling section 1430 is in turn attached to wall sections 1435, 1440, 1445, which each have upper and lower wall portions rotatably attached to one another. While wall sections 1440 and 1415 are disposed in vertical alignment with one another, this configuration may be changed as appropriate for the design of the interior walls of the structure.

[0092] The upper portions of wall sections 1435, 1440, 1445 are rotatably attached to upper ceiling section 1450. Roof supports 1460, 1465 are rotatably attached to upper ceiling section 1450. Each roof support 1460, 1465 has a lower roof support portion, 1462, 1467, and an upper roof support portion, 1464, 1469, rotatably attached to the respective lower roof support portion. The upper portion is in turn rotatably attached to the roof 1470. Roof 1470 here is pitched, with two sections 1473, 1475, attached by a hinged or rotating connection. Roof 1470 has notches at 1472 and 1474, to facilitate engagement with upper ceiling section 1450.

[0093] Fig. 15A shows a frame of a building 1500 assembled from segments similar to those shown in Figs. 14 and 15.

[0094] Additional details of a connector useful in the design of Figs. 14 and 15 will now be explained. Referring to Figs. 16 - 19, there is shown, in various positions, an isometric view of a connector 1600 for use in connecting studs in upper and lower sections of a wall in a structure according to the principles of Figs. 14 and 15. It will be appreciated that the details

illustrated in Fig. 16 and discussed below are exemplary, and that alternative designs are possible. Connector 1600 has two sleeves, adapted to receive two studs of sections of a wall. As the wall sections each generally has a number of parallel identical studs, connectors 1600 will typically be arranged adjacent to one another, with each sleeve and arm in the same orientation at any time. The sleeves are connected to one another by arms 1660, 1680, which are pivotally attached to each sleeve. The attachments between arms 1660, 1680 and one of the sleeves is free to slide a selected distance along the axis of the sleeve, thereby permitting the separation between the sleeves to vary. The sleeves are configured to have mating interior surfaces to assist in proper positioning and locking of the upper and lower wall sections. In Fig. 16, sleeve 1620 is adapted to receive one end of a stud of an upper wall section. Sleeve 1620 is generally a rectangular cylinder, open at both ends. The shape of sleeve 1620 is preferably suitable to tightly receive an end of a stud; accordingly, the shape of sleeve 1620 will preferably conform to the shape of the stud.

[0095] Each rod 1660, 1680 may be rotatably attached to sleeve 1640, such as by a pin 1642 securely mounted in a wall of sleeve 1640 and inserted through a bore in a first end of rod 1660. Each rod 1660, 1680 may be rotatably and slidably attached at a second end to sleeve 1620, such as by a pin 1622 securely mounted in a wall of sleeve 1620 and riding in elongated slot 1664 at a second end of rod 1660. Identical hardware may be provided for rod 1680.

[0096] A lower edge of sleeve 1620 is formed to securely engage and register with an upper edge of sleeve 1640. In addition, suitably positioned bores may be provided in sleeves 1620, 1640, to permit insertion of one or more pins to fix the positions of upper and lower wall sections. In the disclosed embodiment, sleeve 1620 has extended legs 1623, 1624 along a lower portion thereof. Mating notches are in an upper edge of sleeve 1640 at 1643, 1644. It will be appreciated that the configuration of the mating surfaces may be altered. The forward wall and forward portions of the side wall of sleeve 1620 are extended, and the side wall extensions have bores therethrough. Side walls of sleeve 1640 have tabs thereon having bores therethrough, which align with bores in side wall extensions of sleeve 1640 to accommodate a pin for locking of sleeves 1620, 1640.

[0097] Fig. 16 illustrates connector 1600 in the orientation achieved when the walls are partially unfolded. Fig. 17 illustrates connector 1600 in an orientation achieved when the wall

sections are still partially unfolded, but closer to being fully unfolded. In Fig. 18, connector 1600 is illustrated in the position obtained when the upper and lower wall sections are in alignment, but partially separated. It will be seen that pin 1622 is near an upper end of slot 1664. In this position, the upper wall is being supported from above. The separation between upper and lower walls may permit clearance for installation of interior partition walls, as described above. In Fig. 19, connector 1600 is illustrated in its locked position.

[0098] It will be appreciated that a similar connector may be employed for connections between a wall section and a bottom floor section, or between a wall section and a roof section or top ceiling section. In this embodiment, one of the sleeves would be oriented, when in the locked position, to receive a stud orthogonal to the stud received by the other sleeve.

[0099] Referring to Fig. 20, an alternative exemplary connector 2000 for use at the intersection of upper and lower wall sections, or for use at an intersection of a wall section and a floor or ceiling section, is illustrated. It will be appreciated that alternative connector designs may be employed. In this example, two sleeves 2010, 2020 are provided. Connector 2000 is shown in a closed orientation. Sleeve 2010 is open at the top to receive a stud, such as from an upper wall section. Sleeve 2010 is also open at one side, so that sleeve 2010 can alternatively receive a joist from a ceiling section. Sleeve 2020 is open on the bottom to receive a stud from a lower wall section, and side to receive a stud from a floor/ceiling section. Brackets 2040, 2050 are provided and positioned on opposing sides of sleeves 2010, 2020. Brackets 2040, 2050 are configured to permit sleeves 2010, 2020, to move vertically relative to one another, and to permit each sleeve to pivot independently of the other sleeve. In this embodiment, brackets 2040, 2050 are pivotally mounted at a fixed position on sleeve 2020 at fixed bolt 2042. Sleeve 2010 is attached on brackets 2040, 2050 so as to be rotatable, and slidable with respect to the brackets, and to be rotatable, with pivot points adjustable with respect to sleeve 2020.

[00100] The lower edge of sleeve 2010 and the upper edge of center sleeve 220 are formed to assist in engaging the sleeves with one another. The configuration of the lower edge of sleeve 2010 may be the same as the configuration shown on the lower edge of sleeve 1620 in Fig. 16, for example. On the upper edge of center sleeve 2020, sidewalls may be extended to have a mating pattern similar to that of sleeve 1640 in Fig. 16. Tabs, as at 2022, may be provided with mating bores that align with corresponding bores in the body of the sleeve, to

permit locking of the sleeves, and hence of the sections. Tab 2022 also restrains the rotation of bracket 2040, thereby assisting in preventing excessive rotation of sleeve 2010 relative to sleeve 2020. Such excessive rotation would be indicative of rotation of an upper wall section and lower wall section relative to one another beyond alignment.

[00101] Referring to Fig. 21, connector 2100 includes sleeves similar to those shown in Fig. 20 are arranged to provide an intersection of upper and lower walls and a floor/ceiling section. In this example, three sleeves 2110, 2120, 2130 are provided. Connector 2100 is shown in an open orientation. Sleeve 2110 is open at the top to receive a stud, such as from an upper wall section. Sleeve 2110 is also open at one side, but the side opening would not ordinarily be employed in this configuration of connector. Sleeve 2120 is open on the side to receive a stud from a floor/ceiling section. Brackets 2140, 2150 are provided and positioned on opposing sides of sleeves 2110, 2120, 2130. Brackets 2140, 2150 are configured to permit each sleeve 2110, 2120, 2130, to move vertically relative to the adjacent sleeve, and to permit each sleeve to pivot independently of the other sleeves. In this embodiment, brackets 2140, 2150 are pivotally mounted at a fixed position on sleeve 2120 at fixed bolt 2142. Sleeves 2110, 2130, are attached on brackets 2140, 2150 so as to be rotatable, and slidable with respect to the brackets, and to be rotatable, with pivot points adjustable with respect to sleeve 2120.

[00102] The lower edge of sleeves 2110, 2120 and the upper edge of sleeves 2120, 2130 are formed to assist in engaging the sleeves with one another. Tabs, as at 2022, may be provided with mating bores that align with corresponding bores in the body of the sleeve, to permit locking of the sleeves, and hence of the sections.

[00103] As noted, the sleeves have mating upper and lower edges, respectively, to maintain the respective wall sections in contact and not movable relative to one another when the weight of an upper wall section, and the other structures bearing on upper wall section, is transferred to lower wall section.

[00104] Referring to Fig. 22, there is shown an exploded view of the details of a window, which may be window 124 shown in Fig. 1. The window itself, shown as 2205, includes an outer frame 2210. The frame is shown here as rectangular, although other window shapes may be used. Details of the window, which may be conventional or not, are a matter of choice of the designer. The frame has on its outer surface a plurality of grooves 2215. Interior window trim

2220 and outer window trim 2230 are shown. Each of interior window trim 2220 and exterior window trim 2230 has tabs 2222 and 2232 thereon. Tabs 2222 on interior window trim 2220 are positioned and dimensioned to fit in grooves 2215 when interior window trim 2220 is positioned properly. Similarly, tabs 2232 on exterior window trim 2230 are positioned and dimensioned to fit in grooves 2215 when exterior window trim 2230 is positioned properly. Ridges 2217 may be provided in grooves 2215. Similar grooves may be provided in tabs 2222 and 2232 to lock tabs 2222 and 2232 in place, thereby assisting in holding exterior and interior window trim in place.

[00105] In the alternative embodiment shown in Fig. 23, a hingedly attached exterior wall, and a folding, integral dormer are illustrated. The use of a hingedly attached exterior wall section removes the step of positioning the exterior wall on the structure. The folding integral dormer speeds the process of incorporating dormers in a structure. It will be appreciated that these two features are independent of one another, and are illustrated together merely for convenience. In order to accommodate the depth of an exterior wall in the folded configuration, the locations of the folds in the side and end walls are selected so that either the side wall is folded over the folded end walls, or so that the end walls fold over the folded side walls. For ease of understanding, the segment is shown fully unfolded in Fig. 23, and successive folding steps are shown in subsequent figures. In the embodiment of Fig. 23, structure segment 410 is shown. For ease of explanation, structure segment 410 in this example has only one story, with a pitched roof and a single dormer. It will be appreciated that the wall folding arrangement described here may be used in other designs of structure segments, including multi-story structure segments, and those with flat roofs or adapted for different roof configurations. Similarly, the dormer description is not limited to the exemplary structure segment shown. Side wall 420 is attached to floor section 415 (not shown in Fig. 23). The attachment between floor section 415 and side wall 420 permits side wall 420 to rotate. Hinges or other appropriate connections may be provided. It will also be appreciated that side wall 420 may be stored for shipping in this configuration, but not rotatably attached to floor/ceiling section 415. However, rotatable attachment avoids the need to align side wall 420 to floor/ceiling section 415. End wall section 430 is shown. End wall section 430 is unitary in this example, but may be made up of two or more sections, which may be rotatably attached to one another. End wall section 430 is rotatably secured to floor/ceiling section 415 at one end thereof, and slidably and rotatably

attached to an upper floor/ceiling section 440 at one end thereof. A similar opposite end wall 431 is provided, as well.

[00106] Roof assembly 450 includes rotatably attached roof sections 452, 454, which are rotatably attached to a ceiling section 440. Roof cap 456 engages interior ends of roof sections 452, 454, to maintain them at a selected orientation relative to ceiling section 440. Interior ends of roof sections 452, 454, are configured and dimensioned to engage with corresponding surfaces in roof cap 456. Roof assembly side wall 458 is rotatably attached to ceiling section 440. Dormer 460 includes a dormer roof 462, end wall 464, and side walls 466.

[00107] Referring to Fig. 24, dormer 460 is shown with its side and end walls folded below roof section 454. Referring to Fig. 25, dormer 460 is shown with dormer roof 462 folded onto roof section 454. Also referring to Fig. 25, roof assembly side wall 458 is shown partially rotated to its shipping position.

[00108] Referring to Fig. 26, the roof cap 456 has been removed, and roof assembly side wall 458 is shown rotated to its shipping position. The upper surface of ceiling section 440 is visible. Roof sections 452, 454 have not yet been rotated to a shipping position.

[00109] Referring to Fig. 27, roof section 454 has been rotated to its shipping position, on roof assembly side wall 458. Roof section 452 remains in its assembled position, and roof assembly side wall 458 can be seen in its shipping position.

[00110] Referring to Fig. 28, roof section 452 has been rotated to its shipping position. The dimensions of roof sections 452, 454, are selected to permit them to fit horizontally with no overlap.

[00111] Referring to Fig. 29, with the roof assembly fully folded to its shipping position, side wall 420 is shown partially rotated between its assembled and shipping positions.

[00112] Referring to Fig. 30, side wall 420 is shown fully rotated to its shipping position. In its shipping position, side wall 420 is generally horizontal, and on the lower floor section.

[00113] Referring to Fig. 31, side wall 420 is shown fully rotated to its shipping position, and end walls 430, 431 are shown partially rotated between their respective assembled positions and their shipping positions. End walls 430, 431 have pivot points above the level of side wall 420, so that end walls 430, 431 may be rotated into a horizontal orientation, parallel to floor section 415, immediately above side wall 420, while remaining rotatably connected to floor

section 415. In this illustration, floor section 415 has integral rigid vertical extensions 416, 417 at each end thereof, to which end walls 430, 431 are rotatably attached.

[00114] Fig. 32 is a somewhat schematic side view of a structure section 410, showing its parts in position for shipping, i.e., in its compact shipping orientation.. Floor section 415 is at the lowest position. Side wall 420 is parallel to and on floor section 415. End walls 430, 431 are parallel to and on side wall 420. It can be seen that floor section 415 has upstanding projections 416, 417. Side wall 420 fits below the level of projections 416, 417. The extensions of the external siding can readily be seen on end walls 430, 431. Ceiling section 440 is parallel to and on end walls 430, 431. Roof assembly side wall 458 is parallel to and on ceiling section 440. Roof sections 452, 454, are parallel to and on roof assembly side wall 458. Dormer walls 464 and dormer roof 462 are parallel to and on the roof sections.

[00115] It will be appreciated that other configurations of dormers, roofs and side walls may be employed. For simplicity of illustration, windows and doors have not been shown in the above illustration.

[00116] A structure and method according to the invention may involve a removable wall section, such as an interior partition wall. Referring to Fig. 33, there is shown one story of a structure segment 3400 in accordance with the invention, somewhat schematically. Structure segment 3400 has floor section 3415, side wall sections 3417, 3418, and ceiling section 3419, with removable wall section 3410 is shown in place. In Fig. 34, ceiling section 3419 is depicted lifted above its closed position. This may be achieved, for example, by using sliding/rotating connectors in an extended position, as shown, for example, in Figs. 6 and 6A. As a result, there is sufficient clearance for the installation and removal of removable wall section 3410. A groove 3420 may be provided in the interior floor of floor section 3415, thereby facilitating proper placement of the removable wall 3410. A similar groove may be provided in ceiling section 3419. Following placement of the removable wall section 3410, the ceiling section 3419 may be lowered to engage the removable wall section 3410 and assist in locking the removable wall section 3410 in place. Additional fasteners, removable or unremovable, may also be added to secure the removable wall section. The installation of items when the ceiling above is in its extended position may be applied to a wide variety of items.

[00117] A variety of devices and methods may be employed for lifting and lowering components of the structure of the invention. In Figs. 35 and 36, a scissors lift device 3500 is shown. Two scissors lifts 3500 are illustrated partially lifting a ceiling section and attached end wall sections above a floor section. The illustrated application is merely an example, and the scissors lift may be employed to lift other structures. More or fewer scissors lifts may be employed as appropriate. Scissors lifts 3500 have a base 3505. Base 3505, in this example, is generally in the form of a rectangle of high strength bars. Longitudinal bars 3507 serve as rails for supporting movable uprights, and transverse bars 3508 support the load of the scissors lift and the load which it carries. However, it will be appreciated that other base designs may be employed. The upper support 3515 may be identical to and interchangeable with the base. Each scissors lift 3500 includes two uprights 3520, 3530. Each upright has upper and lower parts, rotatably attached at an intermediate point. Each part may be a pair of parallel rods of equal length. One upright may be rotatably attached at fixed points to upper and lower bases and the other rotatably and slidably attached to longitudinal bars 3507. Application of force to separate the extended transverse bars can be employed to increase the separation. In Fig. 36, the scissors lift is shown in a closed position.

[00118] Referring to Fig. 37, there is shown wall section 100 with wallboard 124, showing gaps at the upper and lower portions of the wallboard. The gaps provide access for connections between pipes, cables, wires and the like, as well as access to locking devices to secure the positions of wall sections to ceiling and floor sections above and below. Crown molding 125 and baseboard 126 are shown separate from the wallboard in Fig. 37, and applied to the wallboard in Fig. 38. Crown molding and baseboard may be permanently attached to walls and wallboard by such means as screws and nails. Alternatively, attachment may be reversible. A variety of reversible locking mechanisms may be employed to temporarily hold crown molding and baseboard.

[00119] A wide variety of variations in the materials and configurations of a structure and method of the invention are within the scope of the invention. For example, any suitable materials may be employed. Suitable engineered materials may be employed for structural members, by way of example. The number of stories of a structure may be selected depending on the weight to be borne and the properties of the structural members, and structures of more

than two stories are possible. The dimensions of sections of structures may be varied as appropriate to suit differing cargo containers and vehicles. The structures of wall and ceiling sections may be any suitable structures, and are not limited to the use of studs and joists for structural strength. Finish surfaces, utilities, and the like, may be applied at a factory location, or may be added at the assembly location. Rotatable and sliding connections may be employed, or various self-aligning features, may be employed to assist with the proper alignment of sections that are not connected. The types of rotatable connections may vary. The methods used to unfold the parts may vary widely, including the use of fork lifts, cranes, driven pulleys, lifts, and other mechanisms.

[00120] Although the invention has been described in terms of exemplary embodiments, it is not limited thereto. Rather, the appended claims should be construed broadly, to include other variants and embodiments of the invention, which may be made by those skilled in the art without departing from the scope and range of equivalents of the invention.